OFFSHORE STORAGE STRUCTURES

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Ever since the offshore oil industry began to develop in the Gulf of Mexico during the mid 1950's, engineers have, from time to time, looked at the possibility of storing oil offshore as an economical production solution. It seemed apparent that as the industry moved farther offshore, there would be a need, eventually, for offshore storage. As one of the world's leading suppliers of filed-erected storage tanks and plate structures, it appeared natural for the author's company to apply its capabilities to the growing offshore oil industry.

Accordingly, an initial examination was made of various ideas and concepts incorporating experience gained on shore in constructing elevated tanks, low pressure spheres and spheroids, and flat bottom tanks and floating roofs. Not until the mid 1960's, however, were concepts developed which seemed feasible from an engineering standpoint and at the time attractive to potential users.

One of the first offshore storage structures was a 30,000-barrel (4,770 m³) tank for Tenneco located approximately sixty miles (96.6 km) offshore in 130 feet (139.6 m) of water in the Gulf of Mexico (Figure 1).

The Tenneco tank employs the "over and under" concept wherein 6,000 barrels (950 m³) of oil is stored above the surface of the water in order to resist the buoyant effect of the 24,000 barrels (3,820 m³) of oil stored below water. Operating on the water displacement principal, the structure relies on dead weight and shear cans extending approximately 6 feet (1.8 km) into the sea floor to resist the horizontal and overturning effects of the wave forces.

As shown in Figure 2, oil is first pumped into the upper tank where it then overflow line. The tank is emptied by offloading into barges through the use of pumps and one leg is used for a water or oil in the storage containers, both below and above the waterline. To remove the oil stored in the bottom torus, the water overflow valve is closed and water is pumped into the torus forcing the oil into the offloading lines. After the bottom torus is emptied of oil, the upper tank is emptied by gravity.

The Tenneco tank has been in successful operation for the past seven years and has weathered many of the major storms which have occurred in the Gulf of Mexico during that time. Figure 3 shows the finished structure as it appears today.

Realizing that small capacity storage tanks would not always be economical, designers next turned to larger capacities in an attempt to lower the cost per barrel for offshore storage. The result of this effort was the development of the "Dubai-type" underwater storage tank.

The design and construction by Chicago Bridge & Iron Company of the first 500,000-barrel (79,500 m³) tank for Dubai Petroleum Company (a subsidiary of Continental Oil Company) won an award in 1969 from the U.S. Society of Professional Engineers citing Khazan Dubai No. 1 as one of the eleven outstanding engineering achievements of the year.

This first tank, which has been described in other papers 1,2,3 has operated successfully in the Arabian Gulf for the past three years. The tank operates on the water displacement principle with water flowing freely in and out.

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